

1999

# Context effects on processing lexically ambiguous words.

Gretchen A. Kambe

*University of Massachusetts Amherst*

Follow this and additional works at: <https://scholarworks.umass.edu/theses>

---

Kambe, Gretchen A., "Context effects on processing lexically ambiguous words." (1999). *Masters Theses 1911 - February 2014*. 2347.  
Retrieved from <https://scholarworks.umass.edu/theses/2347>

This thesis is brought to you for free and open access by ScholarWorks@UMass Amherst. It has been accepted for inclusion in Masters Theses 1911 - February 2014 by an authorized administrator of ScholarWorks@UMass Amherst. For more information, please contact [scholarworks@library.umass.edu](mailto:scholarworks@library.umass.edu).





312066 0264 8492 9



CONTEXT EFFECTS ON PROCESSING LEXICALLY AMBIGUOUS WORDS

A Thesis Presented

by

GRETCHEN A. KAMBE

Submitted to the Graduate School of the  
University of Massachusetts Amherst in partial fulfillment  
of the requirements for the degree of

MASTER OF SCIENCE

September 1999

Department of Psychology

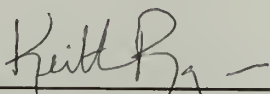
# CONTEXT EFFECTS ON PROCESSING LEXICALLY AMBIGUOUS WORDS

A Thesis Presented

by

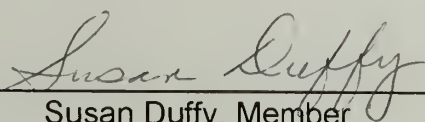
GRETCHEN KAMBE

Approved as to style and content by:



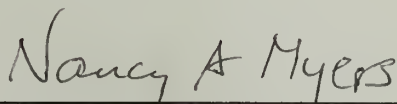
---

Keith Rayner, Chair



---

Susan Duffy, Member



---

Nancy A. Myers, Member



---

Alexander Pollatsek, Member



---

Melinda Novak, Chair  
Department of Psychology

## ACKNOWLEDGMENTS

I would like to thank the members of my committee for their support and valuable input during this project. I would like to begin by thanking my advisor and the chair of my committee, Keith Rayner, who was always generous with his time and was invaluable in ensuring that what I said was concise and consistent with what I wanted to be saying. I would also like to thank Susan Duffy and Nancy A. Myers whose insightful comments and long hours of proof-reading stimuli and manuscripts enhanced this project and improved my writing. Special thanks are also due to Jerome L. Myers, without whom, the process of analyzing the data would have been much more difficult. Charles Clifton Jr. Also deserves my gratitude for his feedback and comments regarding this project along the way.

I would also like to thank Kathy Binder whose dissertation and conversations were the inspiration for this project. Last, but certainly not least, I need to thank my husband. This never would have happened without him.

# TABLE OF CONTENTS

	Page
ACKNOWLEDGMENTS .....	iii
LIST OF TABLES .....	vi
CHAPTER	
1. INTRODUCTION .....	1
Models of context effects on word processing .....	2
Traditional models .....	4
Discourse models .....	7
Hybrid models .....	10
Models of context effects on lexical ambiguity resolution .....	14
2. EXPERIMENT .....	23
Method .....	28
Participants .....	28
Apparatus .....	28
Procedure .....	29
Materials .....	30
3. RESULTS .....	36
Target region .....	36
First fixation effects .....	37
Gaze duration effects .....	38
Total time effects .....	40
Summary of fixation time results for the target region .....	41
Spill over effects .....	44
Summary .....	45
Post target region .....	45
Summary .....	47

Disambiguating region.....	48
Summary .....	53
4. DISCUSSION . ....	54
REFERENCES.....	62

## LIST OF TABLES

### Table

1. List of all ambiguous target and control words .....	30
2. Example Stimuli .....	34
3. First fixation duration (ms) on the target word .....	38
4. Gaze duration (ms) on the target word .....	39
5. Mean total time (ms) on the target word .....	41
6. Spill over effects (ms) from the target word .....	44
7. Mean go past time (ms) on the post target region .....	47
8. Mean first pass time (ms) on the Local Before disambiguating region .....	49
9. Mean total time (ms) on the Local Before disambiguating region.....	50
10. Mean go past time (ms) on the Local Before disambiguating region.....	50
11. Mean first pass time (ms) on the Local After disambiguating region.....	52
12. Mean total time (ms) on the Local After disambiguating region .....	52



## CHAPTER 1

### INTRODUCTION

Ambiguous words offer a unique opportunity to examine the lexical access and integration processes involved in language comprehension during reading. Because of this, a great deal of research has focused on the processes involved in choosing the appropriate meaning of an ambiguous word once it has been encountered. A virtually universal finding is that the context in which a lexically ambiguous word appears plays a role in the disambiguation process. As a result, a great deal of research has focused on determining the exact nature of the role that context plays in processing lexically ambiguous words (Binder, 1999; Binder & Morris, 1995; Dopkins, Morris, & Rayner, 1992; Duffy, Morris, & Rayner, 1988; Kintsch & Mross, 1985; Neill, 1989; Onifer & Swinney, 1981; Rayner & Duffy, 1986; Rayner & Frazier, 1989; Rayner, Pacht, & Duffy, 1994; Sereno, 1995; Sereno, Pacht, & Rayner, 1992; Simpson, 1984; Swinney, 1979; Tannenhaus, Leiman, & Seidenberg, 1979; Till, Mross, & Kintsch, 1988; plus many others). The majority of this research, however, has been devoted to studies using stimulus sets containing only one or two sentences. There has been very little research on the factors influencing lexical ambiguity resolution within longer discourse passages. Understanding how the information provided within a particular discourse influences comprehension is important. During reading, sentences usually appear in a discourse context, not in isolation. It has often been noted that both the prior sentences and the reader's world knowledge can affect the understanding and processing of a series of sentences forming a discourse. As an

individual reads, a coherent discourse representation is formed that impacts the processing of an individual word. It is the impact of discourse-level context effects on lexical ambiguity resolution that will be addressed in this thesis.

A number of models have been proposed to account for the effect context has on word processing. Additionally, there are a number of models which attempt to define the role of context in lexical ambiguity resolution. The research presented here will examine the various models pertaining to context effects on word processing and the role of context in lexical ambiguity resolution in an attempt to find some common ground.

### Models of context effects on word processing

Within language research, context is generally understood to refer to the mental representation formed by an individual when two or more words are strung together. While the exact contents of the mental representation formed from context depends on the theoretical motivations of the individual reader, a broad interpretation is favored here. The mental representation is not restricted to the specific semantic interpretation of the words that make up the context. Indeed, the mental representation derived from a particular context may also reflect the syntactic structure of the words used in that context as well as the reader's general world knowledge. Many researchers, using a variety of methods, have demonstrated that words encountered within a context are processed faster than when found in isolation. For example, processing a word within a sentence is facilitated when the preceding word is semantically related to the target word (Blank & Foss, 1978). When single words are presented sequentially, it has been demonstrated that word processing is speeded if the preceding word is semantically related, and inhibited if the preceding word is semantically unrelated (Meyer & Schvaneveldt, 1971). Facilitation

for lexical processing has been observed through a variety of techniques such as naming latency for a word in a sentence (Stanovich & West, 1979), mispronunciation detection (Cole & Jakimik, 1979), shadowing (Marslen-Wilson & Welsh, 1978), cross-modal lexical decision (Swinney, Onifer, Prather, & Hirshkowitz, 1979), phoneme-triggered lexical decision (Blank, 1980), and eye fixation times (Ehrlich & Rayner, 1981).

Many researchers agree, however, that there is more than one source of contextual influence on word processing (Binder, 1999; Binder & Morris, 1995; Hess, Foss, & Carrol, 1995; Kintsch & Mross, 1985; Rayner, et al., 1994; Simpson, 1984; Till, et al., 1988). For example, when a series of sentences are combined to form a paragraph, the information that affects what is being read and understood comes from multiple sources. The two main sources of information that influence reading comprehension come from the topic of the paragraph and the information contained within a particular sentence. The topic of a paragraph is usually instantiated in the first sentence of the paragraph and provides the reader with a general idea about what is going to be discussed. In the research pertaining to context effects on word processing, the topic of a paragraph is often referred to as the *global* or discourse context of the passage. The information contained within a particular sentence is considered to be the *local* context and usually provides information specific to the ideas being discussed in the paragraph. The specific information making up the local context consists of intra-lexical associations made within the mental lexicon. Most researchers agree on the existence of both a global and local context within a paragraph. Global and local contexts are different in their location in the discourse as well as in the information provided to the reader. Local contextual information is more situation specific than the general representation of the discourse

provided by the global context. Recent research (Binder, 1999; Binder & Morris, 1995; Hess, et al., 1995; Morris, 1994; Schustak, Ehrlich, & Rayner, 1987; Simpson, 1984; etc.) has indicated that global and local contexts affect word processing differently. In the present experiment, an attempt will be made to draw a distinction between the effects of global and local context on word processing.

In their review of the literature, Hess, et al. (1995) defined three types of models of how context affects word processing: traditional, discourse, and hybrid models. According to the traditional model, the effect context has on word processing is local, fast acting, and automatic. It focuses on individual lexical items and their combinations. This type of model suggests that the source of the context effect is within the mental lexicon. Proponents of the discourse model argue that local context has no effect on word processing, and that it is the global or discourse context that causes the increased processing times on the target word. Further, according to the discourse models, the source of the effect is usually located within higher level structures outside of the lexicon. The hybrid models were devised to argue that both global and local contexts have an effect on word processing. Most proponents of the hybrid models also share the view that global and local context effects work separately as two different mechanisms during word processing.

#### Traditional models

The traditional accounts of context effects on word processing have received support from priming studies using word lists (see Meyer & Schaneveldt, 1976) and from studies on the exhaustive access of the meanings of lexically ambiguous words (see Seidenberg, Tanenhaus, Leiman, & Berkowski, 1982; Swinney, 1979). The traditional



model attempted to offer a unified account for the data obtained in both list and sentence processing experiments. The model represents a pure lexical-lexical view which holds that lexical items within the mental lexicon are facilitated through spreading activation. This traditional model of the activation processes, however, has been seriously questioned. Research has shown that studies using word lists do not yield the same results as studies that use words in sentences (e.g. Duffy, Henderson, & Morris, 1989; Foss, 1982; O'Sheaghda, 1989). As a result, a model which attempts to account for the list and sentential data with the same mechanism must be flexible enough to account for the different results. The current versions of the traditional models, however, are unable to account for all of the data.

Several researchers (Duffy et al., 1989; Foss & Ross, 1983; Stanovich & West, 1981, 1983) agreed that a simple traditional lexical-lexical model was insufficient to account for the data. A combination model was proposed to better account for priming effects on lexical access. In their research, Duffy et al. used a subset of the Stanovich and West (1981) sentence contexts to determine the degree to which the individual words within the sentence contributed to priming the target word. The sentence contexts consisted of two content words and a target word (e.g., The barber trimmed the mustache). The content words were the agent and verb of the sentence (barber and trimmed), and the target word was the object of the sentence (the mustache). Duffy et al. systematically replaced each of the content words (e.g., barber or trimmed) with a neutral word (e.g. woman or saw) to determine whether one of the content words was able to prime the target word alone. They found that neither of the content words was sufficient to individually prime the target word. Only when both content words were present and

worked together in combination was the target word facilitated. For example, Duffy et al. found that the combination of lexical items can prime a target word when neither word alone is sufficient to prime the target word. As a result, Duffy et al. argued that the priming effect could not be accounted for with summing activation models because there was no evidence of partial activation in sentence contexts containing a single content word.

Further research by Morris (1994) provided evidence that both lexical and discourse level representations influence access of an individual lexical item within a context. In her first experiment, Morris (1994) like Duffy et al. (1989) found facilitation due to a combination of words that resulted in lexical priming of a target word in a situation where the individual words were not sufficient to prime the target word alone. A second experiment by Morris (1994), however, indicated that further modifications might be necessary for the combination model to fully account for the data. In her second experiment, she added a second set of four conditions in which the relation between the original subject-noun (barber) or its neutral replacement (person) and the verb (trimmed) was altered. A second noun (gardener) and its neutral control (man) were introduced into all eight versions of the stimuli. In the set of four altered conditions, the new noun became the agent of the verb "trimmed". In the original and unaltered conditions, "barber" was the agent of "trimmed". Fixation times on the target word suggested that processing of the target word was influenced by the message-level or discourse context that preceded it. Specifically, in the altered conditions, the target word (mustache) was not facilitated when the discourse context of the sentence was not semantically related (and thus inconsistent) to the target word. The results reported by Morris (1994) implicate both a lexical and a

discourse level impact on lexical access. The discourse level effect on lexical access is contrary to the traditional and the combination models of context effects on word processing. These models predict that lexical items, either alone or in combination, are able to facilitate lexical access via priming. The research conducted by Morris (1994) fails to support either model (the priming effect disappeared in the altered condition). In fact, the data presented above appear to support claims made by the various advocates of the hybrid models of context effects on word processing (described below).

#### Discourse models

Discourse models share the claim that lexical processing is directly affected by the ongoing representation above the word level (Hess et al., 1995). Hess et al. argued that the major, and perhaps sole, source of context effects is derived from the relation between the lexical item and its global or discourse context. In effect, they claim that the local context does not matter and that the locus of context effects is primarily outside of the lexicon. In a series of studies, they reported that unless local context was consistent with global context, there was no evidence that local context played a role in contextual facilitation. They further claimed that facilitation on the target word was robustly correlated to a related global context and that this facilitation was reliable in the absence of local context.

Sharkey and Sharkey (1992) proposed another type of discourse model that differs from Hess et al.'s (1995) view on the effect context has on word processing. Sharkey and Sharkey proposed a lexical distance model in which they argued that all forms of context work together in a top-down activation process that affects access on the target word. They further argued that the entire discourse context is involved in lexical

processing. In fact, lexical information is accessed via a parallel constraint satisfaction search process that activates items in the lexicon on the basis of a goodness of fit function. Lexical information is acquired in the form of graphemic microfeatures activated from the visual input. When words contain the same microfeatures, facilitation occurs because the time to move between these words in the lexicon is reduced. Additionally, response times on a word are faster when the words contain similar features within a discourse context, than when they do not. Priming effects that result from shared microfeatures are not dependent on the presence of word priming. In fact, Sharkey and Sharkey (1992) argue that text priming will occur in the absence of associatively related words preceding the target word. In a series of experiments on text priming, Sharkey and Sharkey found that word priming within the local context was not necessary to facilitate an unambiguous target word.

In fact, in a series of RSVP text priming studies using unambiguous target words, Sharkey and Sharkey (1992) found an effect of global context in the absence of associative prime words in the local context. Semantic associates of the target word, however, did occur earlier in the text. In their third experiment, Sharkey and Sharkey presented their target sentences in isolation. All of these sentences contained a prime word which was associatively related to the linked lexical decision target word. Control sentences were written in which the associative prime was replaced with a word related to the target (but matched on length and frequency to the associative prime). In addition, three delay conditions were included in the experiment: immediately after the critical word in the sentence (no delay), or two or four words further into the sentence. They found no evidence of word priming in any of the three delay conditions. These results support their



hypothesis that (at least for unambiguous words) priming occurs as a result of knowledge structures activated during the processing of earlier portions of the text. One possibility, however, is that the lack of local context effects could be the result of weakly biasing local contexts. The local contexts in these experiments, on their own, were insufficient to cause an effect on the target word.

The lack of any effect for associative word priming in the local context contradicts the results found in the discourse model presented by Hess et al (1995). Hess et al (1995) support the discourse model view that global contextual information guides word processing. In fact, they argue that local contextual information has a very minor role (if any) in contextual facilitation. Contrary to the results obtained by Sharkey and Sharkey (1992), however, Hess et al (1995) found this to be true even when the target sentences were able to facilitate word processing in isolation. It is just that when additional discourse was available, a larger more complete representation was formed allowing it to exert more influence on word processing than local contextual information. This argument was supported by their research.

In a series of cross-modal naming studies, short passages were presented auditorily. Naming times were measures for the last word of the final sentence. In their research Hess et al. claimed to find no evidence of a local context effect on an unambiguous target word in the presence of a global context. When target sentences were presented in isolation, there was a clear effect for the local contexts containing semantic associates to the target word. In Experiment 2, Hess et al. found an effect for global as well as local context. The condition that contained no related information to the target word in either the global or the local condition was then removed and replaced with a

neutral paragraph that did not resemble the other passages. They felt that the global unrelated – local unrelated paragraphs were anomalous. The rest of the experiments in Hess et al. used variations of the neutral passage. No effect of local context appeared in the experiments using the neutral passage as the baseline condition. It is interesting to note that the local context effect was originally apparent in the data. Only after the control condition was changed did the effect disappear. It is possible that the change in materials and the discontinuity between the new control condition and the rest of the stimuli affected the pattern of results. While experiments 5 - 9 were intended to address this issue, they never compared the global unrelated, local unrelated condition to the new control condition which would have been a more conclusive test of the viability of the new control condition and its impact on the resulting data.

### Hybrid models

The three most commonly discussed hybrid models maintain the common assumption that global and local contextual information influence word processing. What is meant by global context is the general discourse or the overall text-based message of the stimuli. Local contexts are usually assumed to reflect the lexical items or words closest to the target stimuli. The hybrid models differ in their descriptions of the exact nature of the source of the context facilitation and about how global and local sources of information relate to each other. A review of the hybrid models will follow.

The construction-integration model proposed by Kintsch (1988) is considered to be an example of a hybrid model. In his model, Kintsch makes a distinction between two stages of processing: the construction phase and the integration phase. In the construction phase, linguistic input and world knowledge are used to access potential interpretations of

the text. This is considered to be a fast, automatic, and imprecise process. Multiple propositions are formed in this stage of processing. These propositions are formed from components associated to an item within the text. Some of the propositions activated may be incoherent and contradictory. The integration phase acts to exclude the unwanted and inappropriate propositions activated during the construction phase of the model. In effect, the integration phase chooses the most appropriate proposition available and attempts to integrate it into the ongoing text representation. This choice is made in a connectionist manner in accordance with the connection strength assigned when the proposition is originally activated in the construction phase. Proponents of this model argue that discourse context is irrelevant to word priming effects in either stage of processing and that what matters is the associative relation between the prime and target words within the local context. Kintsch further argues that text priming relies on the associations made between the related items in the lexicon. He states that words activate their associates immediately, independent of context and that discourse (or global context) information from the text influences the later integration phase of processing. In fact, only if enough time is given for processing a prime word within the discourse context will text priming from the global context be observed on a target word. Research conducted by Kintsch and Mross (1985) and Till, Mross, & Kintsch (1988), support Kintsch's (1988) account of text processing. In Kintsch and Mross (1985) short passages were presented in cross modal (Experiments 1 & 3) and RSVP (Experiments 2 & 4) lexical decision priming experiments. They found that when the target word was related to the discourse meaning of the passage, but was not preceded by a word associate, no facilitation occurred.

In another hybrid model, Schwanenflugel and White (1991) assert that when the paragraph context is the same as the sentence context then there is a higher degree of facilitation than when the paragraph and sentence contexts are different. They argue that the source of context effects on word processing is a feature generation mechanism that is used by an individual when reading. Features are generated from the text via the semantic information provided by the individual words in the text. In addition, the reader uses the semantic relatedness of the words in the text as well as sentence constraint (the scope of facilitation for upcoming words) to generate featural restrictions on upcoming words. When the information presented in the text remains consistent (degree of semantic relatedness), the reader will generate a larger set of features than when the information presented is inconsistent. However, when the reader has generated large sets of features, the amount of facilitation observed increases when the target word matches the features generated by the preceding context. In contrast, when the sentence or discourse is not highly constrained (degree of sentential constraint), fewer features are generated. As a result, the list of potential words is much larger allowing for a smaller and broader scope of facilitation. Further, Schwanenflugel and White argue that when global context is inconsistent with the local context of a discourse, readers may reduce the number of features being generated. This also results in a broader and weaker scope of facilitation. They make an additional claim stating that the reader may just focus less on their expectations in the final sentence when the preceding information did not allow for a large set of features to be generated. The effect that global context has on word processing



operates by modifying the reader's focus of attention or the features generated by the local context. Global and local contexts are considered to be only weakly interactive in this model.

Proponents of the third hybrid model, proposed by Schustack et al. (1987), contend that global and local context effects reflect independent processes in action. Schustack et al. further contend that local context effects come first and reflect word recognition, while global or discourse effects appear later and reflect integration processes. In a multiple task approach using naming time and eye-movement data, Schustack et al. provided evidence in support of their hybrid model. In their experiments they were interested in determining whether a previous occurrence of the target word would affect comprehension. Within the global context, they manipulated how recently the prior mention of a target word occurred. In the local context, they manipulated the degree of semantic constraint between the preceding verb and the target word. If contextual facilitation influences word identification, then the prior occurrence of a word that has been integrated into the mental representation of the discourse passage should facilitate word processing when the same word is encountered a second time. Schustack et al argued that repeating the target word could potentially act as a prime on two levels: at a lexical-level where facilitation occurs as a result of an associative mechanism; or at a discourse level where it "may operate its influence on higher level text units". In the naming task, where integration of the target word was not required, they found that only the local aspects of the stimuli affected naming times. In the eye-movement study where integration of the target word was required, they found that both global and local aspects of the stimuli affected the processing of the target word. Because the reader was required

to continue processing additional text after encountering the target word, Schustack et al. argued that the eye-movement task involved more than just word identification. In the eye-movement task, the meaning of the target word had to be integrated into the ongoing discourse. Global aspects of the stimuli were found to influence facilitation of the target word being integrated into the ongoing discourse. The results of the naming and eye-movement tasks provide evidence for separate sources of facilitation affecting word processing.

### Models of context effects on lexical ambiguity resolution

Much of the research on context effects on lexical ambiguity resolution has been concerned with the impact prior sentential context has on the meaning or meanings being activated when an ambiguous word is encountered. For lexically ambiguous words that are not preceded by disambiguating context (words that are still ambiguous when they are encountered by the reader), most researchers have converged upon a two-stage model to account for the data. The two-stage model consists of a lexical access stage and a selection stage. In the lexical access stage, all meanings of an ambiguous word are initially accessed. In the selection stage, only one meaning of the ambiguous word is activated. The frequency of the meanings of the ambiguous word governs the timing of meaning access. For example, balanced ambiguous words (words with two equally likely meanings) show a pattern of both meanings being simultaneously activated when encountered in a non-disambiguated context (Seidenberg, Tannenhaus, Leiman, & Beinkowski, 1982; Swinney, 1979). For biased ambiguous words (words with one very likely and one less likely meaning), both meanings are accessed (Onifer & Swinney, 1981), but the more likely (dominant) meaning becomes available prior to the less likely (subordinate) meaning

(Simpson & Burgess, 1985). Thus, in the lexical access stage of the model, all possible meanings of the ambiguous word are being exhaustively accessed according to their meaning frequency. The lexical access stage is followed by the selection stage where one of the previously activated meanings is selected. If the selected meaning is not compatible with subsequent disambiguating information, a reanalysis of the ambiguous word may occur.

The two-stage model of lexical ambiguity processing further states that balanced ambiguous words should take longer to process than biased ambiguous words and unambiguous control words. This is believed to occur because the time involved in lexical access and meaning selection between two equally possible meanings is longer than what is required for lexical access of a single or highly dominant meaning. Further, once two equally likely meanings have been activated, the process of integrating one of the meanings into the ongoing text representation may require more time because the appropriate meaning must first be selected. Unambiguous words are not subject to such a selection process. It is possible that because a single dominant meaning becomes available first, biased ambiguous words are also not subject to this selection process.

Little disagreement exists in the literature when no disambiguating information is available prior to encountering the ambiguous word. A lot of controversy exists, however, in relation to context effects on ambiguity resolution when disambiguating information is available prior to the ambiguous target word. As a result, three different types of models have been developed to account for the effect context has on accessing and processing lexically ambiguous words. These three models are the *selective access model*, the *exhaustive access model*, and the *re-ordered access model*. According to the

*selective access model* of lexical ambiguity resolution, prior disambiguating information serves to activate only the contextually relevant meaning of an ambiguous word (Glucksberg, Krueger, & Rho, 1986; Paul, Kellas, Martin, & Clark, 1992; Schvaneveldt, Meyer, & Becker, 1976; Simpson, 1981; Simpson & Krueger, 1991; Swinney & Hakes, 1976; Tabossi, 1988; Tabossi, Columbo, & Job, 1987).

Several studies, however, have demonstrated that all meanings of an ambiguous word are initially accessed (Conrad, 1974; Kintsch & Mross, 1985; Lucas, 1987; Onifer & Swinney, 1981; Seidenberg, Tannenhaus, Leiman, & Bienkowski, 1982; Swinney, 1979; Tannenhaus, Leiman, & Seidenberg, 1979; Till, Mross, & Kintsch 1988) consistent with an *exhaustive access model*. While the exhaustive access model has received much support, it has also been shown that the relative dominance of the various meanings of the ambiguous word influences how the meanings are accessed (Tabossi, 1987). According to the exhaustive access model all meanings are accessed simultaneously. In a series of lexical decision experiments, Tabossi found that all meanings of a balanced and biased ambiguous word were accessed. The dominant meaning of a biased ambiguous word, however, became available prior to the subordinate meaning of the word. This finding as well as others (Burgess & Simpson, 1988; Simpson, 1981; Simpson & Burgess, 1985; Tabossi, 1987) are problematic for the exhaustive access model.

Several other studies have demonstrated that discourse context as well as meaning dominance plays a role in the resolution of lexically ambiguous words (Binder, 1999; Binder & Morris, 1995; Dopkins, Morris, & Rayner, 1992; Duffy, Morris, & Rayner, 1988; Neill, 1989; Neill, Hilliard, & Cooper, 1988). This research supports the *reordered-access model* developed by Duffy et al. (1988). Although, the reordered-access



model (Duffy et al., 1988) also maintains that all meanings of an ambiguous word are accessed regardless of context or meaning dominance, the order of access is argued to be guided by meaning dominance. The reordered-access model also differs from the exhaustive access model with respect to the role that context plays in the resolution process: context can reorder the availability of the meanings of an ambiguous word by increasing the level of activation of the contextually appropriate meaning. This results in speeded access of the most appropriate meaning.

Several recent eye movement studies have provided evidence in support of the reordered-access model (Binder, 1999; Binder & Morris, 1995; Dopkins, Morris, & Rayner, 1992; Duffy, Morris, & Rayner, 1988; Rayner & Duffy, 1986; Rayner & Frazier, 1989; Rayner, Pacht, & Duffy, 1994; Sereno, 1995; Sereno, Pacht, & Rayner, 1992). In these studies, eye movements were monitored as subjects read sentences or short paragraphs, and fixation times on ambiguous words and control words (matched in length and frequency of occurrence) were measured. When the preceding context was neutral, readers fixated longer on balanced ambiguous words than on either biased ambiguous words or unambiguous control words. No difference in reading times were found between the biased ambiguous words and the control words. However, significantly more time was spent on the disambiguating post target region in the sentences where the biased ambiguous words were consistent with the subordinate meaning of the word. This suggests that the reader originally interpreted the biased ambiguous words in accordance with its dominant meaning. This makes sense if the dominant interpretation is available prior to the subordinate meaning of a biased ambiguous word in neutral sentence contexts. The reader would have accepted the first available meaning of the biased ambiguous target

word (the dominant meaning) and integrated it into the ongoing sentence context. This would have taken the same amount of time as processing an unambiguous target word as both would be initially interpreted as consisting of a single meaning. In addition, when the disambiguating information preceded the ambiguous word, fixation times on the biased ambiguous words, where the subordinate meaning was instantiated, were longer than fixations on balanced ambiguous words, unambiguous control words, or biased ambiguous words that were disambiguated toward the dominant meaning. Rayner et al. (1994) referred to this slowdown that occurs when the subordinate meaning is instantiated as the *subordinate bias effect*. When disambiguating information related to the subordinate meaning of an ambiguous word is available in the preceding local context, the level of activation for the subordinate meaning is increased. This causes competition between the subordinate and dominant meanings of the word, making a decision process necessary, and thereby causing the processing time on the target word and/or disambiguating region to be inflated.

The subordinate bias effect is strong and remains consistent despite efforts to eliminate or reduce its effect. For example, in a study performed to determine whether certain types of constraints on a context can lead to selective activation, Rayner et al. (1994) focused on the subordinate bias effect. They wanted to know if a prior encounter with a subordinately biased ambiguous word increases the availability of the subordinate meaning, enough for it to be selectively accessed upon a second encounter of the same subordinately biased ambiguous word. Using both single sentences and short passages, Rayner et al. failed to eliminate the subordinate bias effect. In other words, a prior encounter of a subordinately biased ambiguous word was not sufficient to allow for

selective activation of the subordinate meaning of an ambiguous word when it is encountered a second time in a context still biased toward the subordinate meaning of the word (see also Binder & Rayner, 1998 for further evidence that strong contexts do not eliminate the subordinate bias effect).

Binder and Morris (1995) also investigated repetition effects on selective activation for a particular meaning of an ambiguous word. In their study, they examined the impact a prior encounter with a balanced ambiguous word had on a later encounter with the same ambiguous word. In an eye-movement study, subjects read passages containing two instances of the same ambiguous word. The meaning of the ambiguous word was either maintained or changed within the local context between the first and the second encounter of the word. The global or discourse topic of the passage was also manipulated such that it either remained the same or changed between encounters of the ambiguous word. Consistent with a reordered access model, repetition of meaning facilitated processing of the target word on its second encounter regardless of the discourse structure of the passage. These results support a view consistent with those proposed in the hybrid models of context effects on word processing. Binder (1999) and Binder and Morris (1995) found that local context appears to impact initial processing measures consistent with lexical access (as indicated by faster reading times on the target word). The discourse content of the passage showed later processing effects such as meaning integration (as indicated by spill over processing and increased reading times on the word(s) immediately following the target word).

In another eye-movement study, Binder (1999) examined the locus of global and local context effects on lexical ambiguity resolution. Using both biased and balanced

ambiguous words in short paragraphs, she manipulated global and local context effects independently. Within the local context (the word or words immediately preceding the target word), the disambiguating information always preceded the ambiguous target word. The global context (the “discourse topic” instantiated in the topic sentence of the paragraph), however, was arranged into three topic conditions. In the first topic condition, the discourse topic was consistent with the dominant meaning of the ambiguous word. In the second condition, the discourse topic instantiated the subordinate meaning of the same ambiguous word. In the third topic condition, the discourse topic was neutral with respect to both meanings of the ambiguous target word. The information presented in the sentence containing the local context and the target word never shifted or altered the meaning of the passage. Binder (1999) found no differences in reading times on the target word when comparing the three topic conditions. These results indicate that topic was not affecting the early stages of word processing. Only the later stages of processing, such as meaning integration, seemed to be affected by discourse-level context. Reading times in the post target region were significantly slower when the topic information was inconsistent with the local sentence contextual bias. As a result, local contextual information was argued to be the source of the initial lexical access of the target word. The global contextual information was argued to affect later processing measures. These results are consistent with both the reordered access model and a hybrid view of context effects on word processing.

The above eye-movement studies contrast with the position held by Hess et al. (1995) who disagree with the hybrid accounts of context effects on word processing. In a cross modal task, Hess et al. presented a series of short passages auditorily, and measured



naming times for the last (visually presented) word in the passage. Hess et al. manipulated global and local contexts within short passages, and found that only the global or discourse level context showed an impact on lexical access. The topic of the passage was either related or not to the meaning of an unambiguous target word. The local context was contained within the same sentence of the passage as the target word and consisted of semantic associates to the target word. The semantic associates either preceded the target word or were not present in the target sentence. In contrast to Binder (1999) and Binder and Morris (1995), Hess et al. (1995) found "slim evidence that local context plays any role in contextual facilitation". Hess et al. argued that contextual facilitation only occurred when the global context was related to the target word. They further argue that global context has an immediate effect on lexical access. The "slim evidence" found by Hess et al, however, is an effect of local context in the presence of global contextual information in their second experiment. Before the control condition (global unrelated, local unrelated) was changed to a neutral paragraph, unrelated to the other stimuli, an effect of local context was found. When the new control condition was used (Experiments 3 - 9), no effect of local context was obtained. The discrepancy between Hess et al and Binder (1999) and Binder and Morris (1995) may result from the manipulation used in Hess et al's (1995) Experiments 3 through 9 from which they argued that local context does not affect word processing. Even though evidence indicates that context has an effect on word processing and ambiguity resolution, the specific role that the different types of context play is less clear. For example, Hess, et al. (1995) argue that local context is irrelevant to word processing. Rayner and colleagues assert that both global and local context play a role in the resolution process. Hess et al. further contend that facilitation

from context only occurs when the global context is related to the target word, irrespective of the local context. Binder (1999), Binder and Morris (1995), and Schustack et. al (1987) argue that local context influences the initial stages of processing (e.g. lexical access) and global context influences post-access processes (e.g. meaning selection, elaboration, and integration). While these studies have demonstrated evidence for both global and local context effects on word processing, the debate regarding the individual contribution of each type of contextual information has not been resolved.

## CHAPTER 2

### EXPERIMENT

The goal of the present experiment was to examine the individual contributions of global (discourse-level) and local (lexical-level) context effects on lexical ambiguity resolution. In order to distinguish between the effects caused by global and local contexts and examine their impact on lexical ambiguity resolution separately, a linguistic distinction was made. Global context will refer to the overall meaning of the text as well as to the reader's knowledge of the situation presented in the text. Local context will refer to the information resulting from intra-lexical associations made within the mental lexicon. The global context was instantiated in the topic sentence of the passage, and the local context was contained within the target sentence of the passage. Two filler sentences intervened between the global and local contexts to further distinguish which type of context was impacting the processing of the target word.

In this experiment, individuals were asked to read passages containing biased ambiguous words while their eye-movements were monitored. The ambiguous words were always biased towards their subordinate meaning (see Table 2). The local context consisted of semantic associates to the target word that were intended to bias the reader towards the subordinate meaning of the ambiguous target word. Local context was manipulated such that the disambiguating information either preceded or followed the ambiguous target word. Global context was always presented in the first sentence of the passage and was consistent with either the dominant or the subordinate meaning of the ambiguous word. Conditions in which the topic and target sentences were biased towards

different meanings of the ambiguous word did not contain a shift in topic, and the overall meaning of the passage never changed. Example passages as described in the method section are in Table 2.

The experimental paragraphs were divided into regions or sections of text varying in size (from a single word to a complete sentence). Fixation times in these regions were examined to assess the individual contributions of the global and local contexts. The regions that were expected to be the most informative are the target region, the post target region, and the disambiguating region. The target region consisted of a biased ambiguous word or an unambiguous control word matched on length and frequency of occurrence in the English language. The post target region began immediately after the target word and consisted of two to five words. The post target region contained no semantic associates to either meaning of the target word. The disambiguating region either began the target sentence and ended at the target word, or began at the end of the post target region and extended to the end of the target sentence. When the disambiguating information came after the target word, the beginning of the sentence contained neutral context. When the disambiguating information preceded the target word, the end of the sentence consisted of a logical continuation of the sentence.

Different predictions can be made with respect to the impact that global and local contexts have on word processing. If global and local contexts are distinct in their effect on word processing, then the effect of local context (which consisted of the disambiguating information) should not interact with the effect of global context (which consisted of the topic sentence). For example, when the local context precedes the target word, the subordinate bias effect should occur irrespective of the global context.



Furthermore, if the local context follows the target word, then the subordinate bias effect should not appear on the target word, regardless of the global context. If global context impacts only post access measures, then its effect should be found within the post target regions. This effect would be apparent in the condition where the global context biased towards the subordinate meaning of the ambiguous word and the local context followed the target word. The influence of global context in the presence of preceding local contextual information, however, could manifest itself in two different ways: it could help the reader recover from the subordinate bias effect in the global subordinate topic sentence condition, and/or it could delay recovery in the global dominant topic sentence condition.

However, it is possible that the global and local contexts are not distinct sources of information that affect different stages of word processing; global context might also affect the initial stages of word processing. For example, with globally subordinate contextual information and post target local context, it is possible that the global context will have an immediate impact on lexical ambiguity resolution. For example, the subordinately biased global context may be sufficient to produce the subordinate bias effect on the target word in the absence of immediately preceding disambiguating information. The global context may also influence the magnitude of the subordinate bias effect, with two consistently biasing global and local contexts providing a smaller subordinate bias effect than conflicting sources of contextual information or a single source of biasing contextual information. This is not to say that the studies suggesting that global context effects only reflect later processing measures are incorrect. An alternative point of view suggests that global context can have an early effect on the initial stages of word processing, but only in the absence of local contextually biasing

information. It is just that when the local contextual information is also present, its proximity to the target word makes the impact of the local context stronger and more immediate. It thus masks any possible facilitation effects represented by the global context on the target word. What is seen instead are the later additional integration effects of the global context, after the local context effects have diminished.

If global and local context effects do not affect different stages of word processing (with local context having an immediate impact on ambiguity resolution and global context influencing post access processing) then there should be differences in the reading times for the ambiguous target word compared with the control word in all of the conditions that contain subordinately biased contextual information prior to encountering the ambiguous word. In effect, the subordinate bias effect will occur in three of the four experimental conditions. In addition, there should be no difference in reading times between the ambiguous target word and its corresponding control word in the fourth condition containing the global dominant contextual information and post target local disambiguating information (i.e., no preceding subordinately biased contextual information). If global and local context both independently affect the initial stages of word processing, the magnitude of the subordinate bias effect should change depending on the amount of biasing contextual information available prior to encountering the ambiguous target word. For example, in the Global Subordinate Local Before condition, two sources of biasing contextual information are available prior to encountering the target word. The level of activation for the subordinate meaning of the ambiguous target word should be greater in this condition than in the Global Subordinate Local After condition where there is only one source of biasing contextual information prior to

encountering the ambiguous target word. As a result, the magnitude of the subordinate bias effect should change between the different experimental conditions. If global and local contextual information influence different stages of word processing, there should be no difference in reading times for the ambiguous target word compared with the control word when the local disambiguating information follows the target word, regardless of the bias of the global contextual information. Any effect of global context would be found in the post target regions.

As can be seen, there are a number of possible predictions with respect to global and local context effects on lexical ambiguity resolution. The hypothesis favored in the present experiment is the one in which no distinction is made between the source of the information provided by the global and local contexts. It is possible that global and local contexts affect word processing in a similar manner. It may just be that global contextual information is more distant or more deeply ingrained into the discourse representation. As a result, it is possible that when no preceding local contextual information is available, global contextual information will have an immediate impact on word processing. As a result, the subordinate bias effect is predicted to occur whenever subordinately biased disambiguating information is available prior to encountering the ambiguous target word. No difference is expected to occur between the ambiguous target word and its corresponding control word with dominantly biased global context and post target local context.

Another important manipulation in the current research consists of the three target regions which are intended to assist in isolating the different effects that global and local contexts have on word processing. A neutral region (containing no semantic associates of

the target word) was inserted between the target word and the disambiguating context in the conditions where the local context followed the target word. This neutral region was intended to separate the effects caused by the global context on the target word from the effects that result from the disambiguating information that followed.

### Method

#### Participants

Forty-eight members of the University of Massachusetts community received payment or course credit for their participation in the study. All participants were native English speakers with normal or corrected vision and were naïve with respect to the purpose of the study.

#### Apparatus

Eye movements were recorded by a Fourward Technologies Dual Purkinje Eyetracker (Generation V). The eyetracker has a resolution of less than 10' of arc. The participants' view of the screen was binocular, but only the right eye was monitored for eye location. The signal from the eyetracker was sampled every millisecond by a 486 computer. The average vertical and horizontal positions of the eye were compared with those of the previous position to determine whether the eye was fixated or moving. The passages were double-spaced and presented on a NEC MultiSync 4FG color monitor. During the experiment, all participants were seated 60 cm from the monitor with three characters equaling 1 degree of visual angle. The luminance of the screen was adjusted to a level of brightness that was most comfortable for the participant and then held constant throughout the study. The experimental room was dark except for a small indirect light that enabled the experimenter to keep notes during the experiment.



## Procedure

When a participant arrived for the experiment, they were given a general description of the experimental situation and procedure. Participants were told that they would be expected to read a series of passages on a computer screen while their eye movements were being monitored. They were also told that they would occasionally be asked comprehension questions about the passage they had just read. All comprehension questions consisted of yes/no questions that were answered by clicking a button. Approximately 25% of the passages were followed by a question. After each participant understood the procedure and signed an informed consent, a bite bar was prepared in order to eliminate head movements.

Once the participant was seated in front of the monitor, an initial calibration procedure that took approximately five minutes was completed. The calibration of the eye tracking system was checked regularly to ensure that accurate records were being obtained. Calibration was checked on a screen that appeared between each passage. The screen consisted of two rows of five boxes arranged parallel to each other. Additionally, a single box lie in the center of the screen between the two rows of boxes. The top row of boxes corresponded to the location of the first line of text. Between each trial, the subject was asked to fixate on the box in the center of the screen, then on the center of the top row of boxes. Next, the participant was asked to move his/her eyes across the top row, box by box, to the left. The far-left box marked the location of the first letter of the paragraph. As soon as the experimenter determined that the participant was fixating on the far-left box, the entire passage was presented onto the screen. The participant was told ahead of time to click a button to erase the passage from the screen when they had

completed reading it. Once the passage had been erased and the trial ended, the two rows of boxes again appeared on the screen. The participants were told to fixate on the far-left box when they were ready for the next passage. This procedure was repeated throughout the entire practice and experimental sessions.

### Materials

Twenty-four ambiguous words were chosen from a series of norms collected at the University of Massachusetts, as well as published norms (Twilley, Dixon, Taylor, & Clark, 1994). Only biased ambiguous words were used in the present study. The dominant sense of these biased ambiguous words had a probability range of .83 - .100 with a mean of .90. The subordinate sense of these biased ambiguous words had a probability range of .01 - .14 with a mean of .06. Each ambiguous word was paired with a unambiguous control word that was matched in length of letters and frequency of occurrence in accordance with the Francis and Kucera (1982) norms (see Table 1). Control words were selected to be consistent with subordinate sense of the ambiguous target word and the local contextual information. The average word frequency count for the biased ambiguous words was 80.6 (range 1-361), and their matched control words was 80.5 (range 3-342).

Table 1. List of all ambiguous target and control words

Ambiguous Target Words	Control Words
cabinet	analyst
port	beer
bank	edge
notes	songs
boxer	puppy
speaker	machine
pipes	drain
poker	sword
band	gold

continued on next page

Table 1. continued

ball	test
coach	cabin
scale	stone
wire	card
horn	tail
racket	tenant
diamond	parkway
table	paper
legend	harbor
story	floor
plant	hotel
corn	wart
pen	zoo
habit	cross
mint	jail

---

For each word pair, two different passages were constructed in which each member of the word pair fit smoothly into the passage frames. Each passage contained a topic sentence, two filler sentences, and a target sentence. The topic sentence introduced the global context, which was related to either the subordinate or dominant meaning of the ambiguous word. The target sentence contained the local context, and was biased towards the subordinate meaning of the ambiguous target word. The disambiguating information either preceded or followed the target word.

The topic of the discourse passage was introduced in the first sentence of each passage and established a situation that was either consistent with the subordinate meaning of the ambiguous word (i.e. global subordinate) or consistent with the dominant meaning of the ambiguous word (i.e. global dominant). For example, in the global subordinate (GS) condition (see Table 2) the topic sentence for the ambiguous word *band* was: "Lisa and John spent months looking for the perfect wedding ring". The topic sentence for the global dominant (GD) condition was: "Lisa and John loved to go to rock concerts with their friends". In this way, when the subordinate meaning of the ambiguous target word was

instantiated in the topic sentence, a scenario consistent with the subordinate meaning of the ambiguous word *band* (as in jewelry) had been presented. The same was true for the conditions in which the dominant meaning of the ambiguous word *band* (as in music) had been instantiated in the topic sentence. Each topic sentence was followed by two neutral filler sentences (see Table 2). The same two filler sentences were used across all passage conditions. The filler sentences, were congruous continuations of the initial sentence (regardless of the topic condition), and were neutral with respect to the different meanings of the ambiguous words.

The target sentence of each passage contained the local context and was always semantically biased toward the subordinate meaning of the ambiguous target word. For example, in a passage in which *band* was the ambiguous word, the local context was always biased towards the jewelry meaning of the word. The semantically biasing information in the local context was manipulated such that the disambiguating information either preceded or followed the target word. Thus, when disambiguating information preceded the target word, semantic associates related to the subordinate meaning of the ambiguous word (such as "jewelry store") were available prior to encountering the target word. The sentence: "It wasn't until they entered Kay's Jewelry store that they saw the band..." (see Table 2), is an example of the conditions in which the local contextual information was available before the target word was encountered (LB). When the local information was not available until after encountering the ambiguous word, no semantic associates for either meaning of the ambiguous word were available prior to encountering the target word. The sentence: " One day they decided to go to New York City to see the band..." (see Table 2), is an example of the conditions where the local context was



available after the ambiguous word was encountered (LA). As a result, in the conditions where the disambiguating information followed the target word, only the dominant meaning of the ambiguous word should be readily available when the ambiguous word was encountered (assuming that the dominant meaning is available prior to the subordinate meaning of the biased ambiguous target word). Two post target regions followed the target word. The first consisted of 2-5 words and was neutral with respect to either meaning of the ambiguous word; the second contained either the disambiguating information or a natural continuation of the sentence.

There were a total of eight within-subjects conditions formed by crossing three conditions: global context (subordinate vs. dominant), local context (before vs. after the target word), and ambiguity (ambiguous vs. control). All eight factors were counterbalanced using a Latin-square design, and the order of presentation was always randomized. Each participant saw 48 experimental passages, six passages in each of the eight conditions. They saw every ambiguous word as well as its matched control word, although the ambiguous words and their matched controls were always presented in different passage frames. So, if the individual saw the ambiguous target word in the rock concert passage, he/she would encounter the control word in the other passage frame (the rock star interview paragraph). As a result, no target word, control word, or passage frame was ever repeated for a particular participant. Both versions of an example paragraph are presented in Table 2.

Table 2. Example Stimuli

*Version 1*

**Global Subordinate - Local After (GSLA)**

Lisa and John spent months looking for the perfect wedding ring. They had a great time traveling around together. They were especially pleased that they both liked the same kinds of things. One day they decided to go to New York City to see the **band/gold** that would be made into an exact duplicate of a ring worn by Cleopatra.

**Global Subordinate - Local Before (GSLB)**

Lisa and John spent months looking for the perfect wedding ring. They had a great time traveling around together. They were especially pleased that they both liked the same kinds of things. It wasn't until they entered Kay's Jewelry store that they saw the **band/gold** that would make the perfect wedding ring for both of them.

**Global Dominant - Local After (GDLA)**

Lisa and John loved to go to rock concerts with their friends. They had a great time traveling around together. They were especially pleased that they both liked the same kinds of things. One day they decided to go to New York City to see the **band/gold** that would be made into an exact duplicate of a ring worn by Cleopatra.

**Global Dominant - Local Before (GDLB)**

Lisa and John loved to go to rock concerts with their friends. They had a great time traveling around together. They were especially pleased that they both liked the same kinds of things. It wasn't until they entered Kay's Jewelry store that they saw the **band/gold** that would make the perfect wedding ring for both of them.

*Version 2*

**Global Subordinate - Local After (GSLA)**

Mary Jo was surprised that the actor was wearing a wedding ring. She had been at the interview for fifteen minutes. Everything was going well and she was very pleased. She could not help but notice the elaborate engraving that decorated the **band/gold** that he had on his ring finger.

**Global Subordinate - Local Before (GSLB)**

Mary Jo was surprised that the actor was wearing a wedding ring. She had been at the interview for fifteen minutes. Everything was going well and she was very pleased. The conversation continued to flow and eventually turned to the **band/gold** that he had engraved by a jeweler as surprise for his wife.

continued on next page

Table 2. continued

**Global Dominant - Local After (GDLA)**

Mary Jo could not believe that she got to meet Bono from U2. She had been at the interview for fifteen minutes. Everything was going well and she was very pleased. She could not help but notice the elaborate engraving that decorated the **band/gold** that he had on his ring finger.

**Global Dominant - Local Before (GDLB)**

Mary Jo could not believe that she got to meet Bono from U2. She had been at the interview for fifteen minutes. Everything was going well and she was very pleased. The conversation continued to flow and eventually turned to the **band/gold** that he had engraved by a jeweler as surprise for his wife.

## CHAPTER 3

### RESULTS

Processing time measures were calculated for three regions within the target sentence: the target word (target region), the region immediately following the target word (post target region) consisting of 2-5 words (which were identical across conditions), and the disambiguating region (which averaged about 12 words). Analyses of variance (ANOVA) were performed on these data using both subjects (F1) and item (F2) variability.

#### Target Region

The primary processing time measure that was calculated for the target region was the *gaze duration* on the target word. Gaze duration is conditional on the word being fixated and is calculated by summing all consecutive fixations on a word before leaving that word. Thus, this measure consists of the processing time involved in the reader's initial encounter of the target word, and does not include any regressions from other regions of the text. If a target word was not actually fixated, the closest fixation within three character spaces to the left and one to the right, was counted as the fixation during which the target word was processed (Rayner & Pollatsek, 1989). Fixations less than 100 ms. in duration were eliminated as such short fixation times are assumed to reflect oculomotor programming or processing that actually took place during the prior fixation (Morrison, 1984). Additionally, fixation times longer than 800 ms. were assumed to reflect track losses or eye blinks, and were thus eliminated. This resulted in 7% of the data being excluded from the analyses.



In addition to the gaze duration, the total time on the target word was calculated. The total time measure includes all fixations on the target word, including regressions back to it. Another measure that is often analyzed in eye movement studies is the first fixation duration. The first fixation duration is conditional on the word being fixated and consists of the duration of the first fixation on a word regardless of how many additional times the reader fixated on the word. While in many contexts this measure has provided valuable information, in most studies dealing with eye movements and the processing of lexically ambiguous words, the gaze duration has turned out to be the most informative measure. In the present study, as in many other prior studies (see Rayner et al., 1994), the pattern in first fixation duration and gaze duration was similar.

#### First fixation effects

Table 3 contains the first fixation times on the target word for the various conditions in the experiment. A 2 (Global context: Subordinate vs. dominant interpretation) X 2 (Local context: Before vs. after) X 2 (Ambiguity: Ambiguous vs. control) ANOVA was performed on the first fixation data. First fixations were longer on ambiguous target words compared with the corresponding unambiguous control word, as indicated by a significant main effect of ambiguity,  $F(1,47) = 5.36$ ,  $p < .05$ ,  $MSE = 1469$ , and  $F(1,47) = 4.02$ ,  $p = .05$ ,  $MSE = 2192$ . Further examination of the means in Table 3 clearly reveals that for the Global Subordinate Local Before, the Global Subordinate Local After, and the Global Dominant Local Before conditions there was a numerical difference between the ambiguous target word and the control word (ranging between 7 and 19 ms), while for the Global Dominant Local After condition the difference between the ambiguous target word and the control word was in the opposite direction. Two

subsequent analyses were performed on the data. These analyses tested the *a priori* prediction that readers would spend more time on the ambiguous target word than on the corresponding control word for the Global Subordinate Local Before, Global Subordinate Local After, and the Global Dominant Local Before conditions, but that there should be no difference in reading times for the ambiguous and control word in the Global Dominant Local After condition. First, an ANOVA which included the Global Subordinate Local Before, Global Subordinate Local After, and Global Dominant Local Before conditions (thus, this analysis did not include the Global Dominant Local After condition) confirmed that readers spent more time on the ambiguous target word compared with the control word as indicated by the significant effect of ambiguity,  $F(1,47) = 8.01$ ,  $p < .01$ ,  $MSE = 1421$ , and  $F(1,47) = 6.70$ ,  $p < .05$ ,  $MSE = 2195$ . Second, for the Global Dominant Local After condition, the means for the ambiguous target word and the control word did not differ,  $F_s < 1$ .

Table 3. First fixation duration (ms) on the target word

	Global Subordinate Context		Global Dominant Context	
	Local Before	Local After	Local Before	Local After
Ambiguous Target	283	283	284	276
Control Target	276	264	268	281
<i>Difference scores</i>	7	19	16	-5

#### Gaze duration effects

Table 4 shows the gaze duration effects on the target word. Gaze duration was slightly longer on the ambiguous target word than the control word as revealed by a marginally significant effect of ambiguity,  $F(1,47) = 3.23$ ,  $p < .08$ ,  $MSE = 1941$ , and

$F2(1,47) = 3.63$ ,  $p < .07$ ,  $MSE = 4229$ <sup>1</sup>. Again, no other effects were significant (all  $F$ 's  $< 1$ ), indicating that the global and local contexts did not act together or separately to reduce the subordinate bias effect on initial processing measures. Again, further examination of the means (in Table 4) clearly reveal that for the Global Subordinate Local Before, the Global Subordinate Local After, and the Global Dominant Local Before conditions there was a numerical difference between the ambiguous target word and the control word (ranging between 13 and 20 ms), while for the Global Dominant Local After condition there was no difference between the ambiguous target word and the control word.

Table 4. Gaze duration (ms) on the target word

	Global Subordinate Context		Global Dominant Context	
	Local Before	Local After	Local Before	Local After
Ambiguous Target	303	304	304	298
Control Target	286	284	291	297
<i>Difference scores</i>	<i>17</i>	<i>20</i>	<i>13</i>	<i>1</i>

Subsequent follow up analyses like those described above for the first fixation measure again revealed that among the first three conditions (Global Subordinate Local Before, Global Subordinate Local After, and Global Dominant Local Before) there was a strong

---

<sup>1</sup> Because there was some variability across target words in terms of word length, an ANOVA was conducted in which the gaze duration was converted to a milliseconds per character measure. This analysis yielded significant effects of ambiguity by subjects,  $F1(1,47) = 5.07$ ,  $p < .05$ ,  $MSE = 2997$ , and items,  $F2(1,47) = 5.55$ ,  $p < .05$ ,  $MSE = 5918$ .

effect of ambiguity,  $F(1,47) = 5.39$ ,  $p < .05$ ,  $MSE = 1495$ , and  $F(1,47) = 4.77$ ,  $p < .05$ ,  $MSE = 4234$ . Second, for the Global Dominant Local After condition, the means for the ambiguous target word and the control word did not differ,  $F_s < 1^2$ .

#### Total time effects

Table 5 contains the total time data. As is evident in the table, the pattern of results for the total time data is very similar to the gaze duration data in that there are differences between the ambiguous target word and the control word for all conditions except the Global Dominant Local After condition. Total times were longer on the ambiguous target word than on the corresponding control word as revealed by a significant main effect of ambiguity,  $F(1,47) = 7.43$ ,  $p < .01$ ,  $MSE = 5788$ , and  $F(1,47) = 5.26$ ,  $p < .05$ ,  $MSE = 12497$ . In addition, there was a main effect of global context,  $F(1,47) = 13.32$ ,  $p < .001$ , and  $F(1,47) = 7.12$ ,  $p = .01$ ,  $MSE = 5784^3$  wherein fixation times on the target word were longer in the Global Dominant conditions (353 ms) than in the Global Subordinate conditions (332 ms). Subsequent follow up analyses like those described above again revealed that among the first three conditions (Global Subordinate Local Before, Global Subordinate Local After, and Global Dominant Local Before) there was a strong effect of ambiguity,  $F(1,47) = 10.21$ ,  $p < .01$ ,  $MSE = 6680$ , and  $F(1,47) =$

---

<sup>2</sup> Reading times on the control word are a bit longer in the Global Dominant Local After condition than in the other control conditions. This difference in mean gaze duration is not significant (all  $F$ 's  $< 1$ ). Because the control words only have one meaning, a decision was necessary as to which context (the subordinate or the dominant) would be most appropriate to have the control word fit into. A completely neutral word would have been anomalous with the entire discourse. The control word was selected to be consistent with the local or subordinately biased contexts. As a result, when dominantly biased context preceded the control word with no preceding subordinately biased contextual information, the control word was not as good a fit into the discourse. This occurred in only one passage condition, and while noticeable to the subject, was very infrequent (occurring 8 times in a total of 48 passages).

<sup>3</sup> Subsequent analysis provides evidence for the post-access influence of the global context. Second pass times indicate that re-reading times were longer in the target region when the global context was biased towards the dominant meaning of the ambiguous target word,  $F(1,47) = 9.15$ ,  $p < .01$ ,  $MSE =$



9.59,  $p < .01$ ,  $MSE = 9487$  such that the readers spent more time on the ambiguous target word compared with the corresponding control word. Once again, the means for the ambiguous target word and the control word did not differ for the Global Dominant Local After condition,  $F1 < 1$  and  $F2 = 1.28$ .

Table 5. Mean total time (ms) on the target word

	Global Subordinate Context		Global Dominant Context	
	Local Before	Local After	Local Before	Local After
Ambiguous Target	344	353	372	354
Control Target	305	327	330	356
<i>Difference scores</i>	39	26	42	-2

#### Summary of fixation time results for the target region

First fixation and gaze duration measures revealed a consistent pattern of results for the first three conditions (Global Subordinate Local Before, Global Subordinate Local After, and Global Dominant Local Before) such that readers spent more time on the ambiguous target word compared to the corresponding control word. The inflated reading times on the ambiguous target word are consistent with prior research (Binder & Rayner, 1998; Rayner et al., 1994) in demonstrating the subordinate bias effect. The subordinate bias effect is an indication of processing difficulty on biased ambiguous words due to competition resulting from increased activation of the subordinate meaning of the ambiguous word. Previous research on the subordinate bias effect has indicated that the immediately preceding sentence context can increase the activation of the subordinate meaning of an ambiguous word, causing competition between the dominant and

---

4063;  $F2(1,47) = 14.54$ ,  $p < .001$ ,  $MSE = 2692$ , as revealed by a main effect of global context.

subordinate interpretations and results in a slow-down in processing. What is interesting to note is that in the present study the subordinate bias effect appeared in a condition that did not contain information which biased towards the subordinate meaning of the ambiguous word in the immediately preceding sentential context. The Global Subordinate Local After condition contained subordinately biasing information only in the topic sentence of the paragraph. Thus, global context had an immediate effect on lexical ambiguity resolution in the absence of local disambiguating information.

The Global Dominant Local After condition showed no difference in processing times between the ambiguous target word and its corresponding control word. This result was expected because the dominant meaning of the ambiguous target word was instantiated in the topic sentence of the paragraph in this condition and no other biasing information preceded the target word. As a result, when the reader encountered the ambiguous target word, the dominant interpretation was readily accepted and integrated into the ongoing discourse representation. The lack of a difference in processing times between the ambiguous target word and control word in this condition is consistent with the re-ordered access model.

The effects found in the target region for the total time measure were consistent with the first fixation and gaze duration results. Again the subordinate bias effect was found on the target word for the first three conditions (Global Subordinate Local Before, Global Subordinate Local After, and Global Dominant Local Before). The total amount of time the reader spent on the target word was longer for the ambiguous target words than for their corresponding control words. Interestingly, the subordinate bias effect did not fade in the Global Subordinate Local After condition despite the lack of any

immediately preceding disambiguating information (although the effect size is statistically significant, it does show the smallest numerical difference (26 ms. as opposed to 39 ms. and 42 ms. for the other two conditions). Although the initial processing measures (first fixation and gaze duration) did not reveal any effect of global context, there was a significant effect of this variable in the total time measure. The reader was more likely to reread the target word when the global context was biased toward the dominant interpretation of the ambiguous word than when the global context was biased towards the subordinate meaning of the ambiguous word (as indicated by the total time analysis as well as the second pass reading times). The pattern of results for the total time analysis were consistent with that of gaze duration and first fixation. The difference is that in total time measures an effect of global context became apparent. The reader spent significantly more time in the target region when the global context instantiated the dominant meaning of the ambiguous word. Presumably the change in bias between the global and local context (whether the inconsistency came before or after the target word) increased the difficulty of comprehension processes for the text. In the Global Dominant conditions, the topic of the paragraph instantiated the dominant meaning of the ambiguous word. The local context, however, was always biased towards the subordinate meaning of the ambiguous word. When this inconsistency was encountered, the reader required additional time to ensure that the appropriate meaning had been integrated into the ongoing discourse representation. It is surprising that there was no garden path effect on the unambiguous target word when the global context was biased towards the dominant

meaning and the local context followed the ambiguous target word. While there was no indication of a garden path effect on the target region, it is very clearly evident in the spill over and post target region analyses.

### Spill over effects

Table 6 shows the pattern of spill over effects, the first fixation immediately following first pass fixations on the target word (fixation  $n + 1$ ). This measure indicates whether the reader is continuing to encounter processing difficulty immediately after the target region. Here, a somewhat different pattern is apparent. There was no main effect of ambiguity (all  $F$ 's  $< 1$ ), indicating that additional processing of the ambiguous target word did not always continue into the following region. There was, however, a significant main effect of global context as the means for the context biasing towards the dominant meaning were longer than those when the context was biased towards the subordinate meaning,  $F(1,47) = 8.54$ ,  $p < .01$ ,  $MSE = 2272$ ,  $F(1,47) = 6.60$ ,  $p < .05$ ,  $MSE = 2175$ . The size of the effect varied as indicated by a three-way interaction between global context, local context, and ambiguity,  $F(1,47) = 4.04$ ,  $p = .05$ ,  $MSE = 2214$ ,  $F(1,47) = 5.57$ ,  $p < .05$ ,  $MSE = 1858$ . Readers spill over fixations were longer for the ambiguous word than the control word primarily in the Global Dominant Local Before condition.

Table 6. Spill over effects (ms) on the target word

	Global Subordinate Context		Global Dominant Context	
	Local Before	Local After	Local Before	Local After
Ambiguous Target	260	265	289	267
Control Target	268	258	270	275
<i>Difference scores</i>	-8	7	19	-8



## Summary

No main effect of ambiguity was found in the analysis for spill over processing in the target region. The main point of interest is that the change in contextual bias between the global and local context for the Global Dominant Local Before condition caused some processing difficulty. Again this effect is not surprising due to the fact that the dominant interpretation of the ambiguous target word was instantiated in the topic sentence of the paragraph, and the immediately preceding sentential context biased towards the subordinate meaning of the ambiguous word. The shift in context increased the processing load for this condition.

### Post target region

The post target region began immediately after the target word and consisted of two to five words that were identical across all passage conditions. This region separated the target word from the disambiguating information that followed (in the conditions where the local disambiguating context followed the target word), so as to avoid a confound between the disambiguating information and spill over processing from the target word. In contrast to spill over, this measure indicates whether any unresolved processing difficulty from the target region is having an ongoing effect on processing. Reading times for the post target region were evaluated to assess the integration processes taking place. Because I was interested in assessing the time course involved in integrating the target word into ongoing discourse, a go past measure of analysis was utilized as the best way to evaluate the data. The particular go-past measure used included only the time spent in the post-target region. Thus, the measure does not include any time spent outside of the post target region during regressions to prior regions of the text. The go-past

measure differs from the total time measure in that the latter includes time on a target region after that region has been read once and is being re-fixated. The go past measure does not include time spent in the region once the reader has moved past it (to the right).

Time spent on the post-target region is presented in Table 7. An overall analysis of variance revealed a significant main effect of global context by subjects,  $F(1,47) = 5.94$ ,  $p < .05$ ,  $MSE = 22140$ , but only a marginal effect by items,  $F(1,47) = 3.38$ ,  $p < .08$ ,  $MSE = 14736$ ; more time was spent in this region when the global context was biased toward the dominant meaning of the ambiguous target word. The two-way interaction of local context and ambiguity reflected that readers spent more time in this region if the local disambiguating information came before the target word, and the target word was ambiguous,  $F(1,47) = 8.24$ ,  $p < .01$ ,  $MSE = 13734$ ,  $F(1,47) = 5.01$ ,  $p < .05$ ,  $MSE = 73312$ . The three-way interaction between global context, local context, and ambiguity, supported the finding that readers spent more time in the post target region after an ambiguous word for the first three conditions (Global Subordinate Local Before, Global Subordinate Local After, and Global Dominant Local Before); however, readers spent more time in the post target region after a control word in the Global Dominant Local After condition,  $F(1,47) = 4.00$ ,  $p = .05$ ,  $MSE = 9865$ ;  $F(1,47) = 4.37$ ,  $p < .05$ ,  $MSE = 11532$ . It is possible that the reversal in the amount of time spent in the post target region for the Global Dominant Local After condition reflects the fact that the control words may have been more suited to the local context than the global context. As a result, the reader appears to slow down while trying to determine how the unambiguous control word (i.e. gold) fits into the global dominant context (i.e. rock concerts). An additional post hoc analysis was performed on the post target region to determine whether

the increased reading time (523 ms) after the ambiguous target word in the Global Dominant Local Before condition was statistically significant. A 2x2 anova was performed on the post target region for the conditions which were preceded by an ambiguous target word. There was a significant interaction between the global and local contexts,  $F_1(1,47) = 5.11$ ,  $p < .05$ ,  $MSE = 53841$ ;  $F_2(1,47) = 6.13$ ,  $p < .05$ ,  $MSE = 38299$ ; readers spent more time in the post target region when the global context was biased towards the dominant meaning and the local context preceded an ambiguous target word. When the same analysis was performed on the post target region for the four conditions preceded by an unambiguous control word, the interaction was not significant (all  $F$ 's  $< 1$ ).

Table 7. Mean go past time (ms) on the post-target region

	Global Subordinate Context		Global Dominant Context	
	Local Before	Local After	Local Before	Local After
Ambiguous Target	474	487	520	470
Control Target	455	477	472	523
<i>Difference scores</i>	<i>19</i>	<i>10</i>	<i>48</i>	<i>-53</i>

#### Summary

The results reported for the post target region are consistent with the spill over effects on the target word. Readers spent the greatest amount of time in the post target region when the preceding global and local contexts instantiated different interpretations of the ambiguous target word. One minor difference, however, is the presence of an interaction between local context and ambiguity. When the immediately preceding sentence context contained the subordinately biased disambiguating information and an

ambiguous target word, readers spent more time in the post target region. This two-way interaction varied such that more time was spent in the post target region when the global context biased toward the dominant meaning of the ambiguous word.

The main point of interest, however, is that readers encountered the most processing difficulty after encountering an ambiguous target word in the Global Dominant Local Before condition (where the global and local contexts are inconsistent) than in any other condition. Readers spent more time in the post target region if the global context was biased towards the dominant meaning of the ambiguous word and the local disambiguating information came before the ambiguous target word. Increased reading times in the post target region suggest that the reader was having difficulty with comprehension processes. Again, this increase in processing time is not surprising in light of the conflicting information that occurs before the ambiguous target word in the Global Dominant Local Before condition. The conflicting information requires the reader to take more time to ensure that they are incorporating the appropriate meaning of the ambiguous target word into the ongoing discourse representation.

#### Disambiguating region

The disambiguating region either preceded or followed the target word. In the Local Before conditions, the disambiguating information preceded the target word: the disambiguating information began the sentence and ended with the onset of the target word. In the Local After conditions, the disambiguating region followed the target word: the disambiguating information began immediately after the post target region and continued to the end of the sentence. The time spent in the disambiguating region was calculated as the sum of all fixations or the total time spent in the region.



The sentence context for the disambiguating information was lexically different in the Local Before conditions than in the Local After conditions (although the overall length of the regions were the same (within 5%)). As a result, the disambiguating regions were analyzed separately. The contexts surrounding the target word were identical in both of the Local Before conditions and also identical in both of the Local After conditions.

Time spent in the Local Before disambiguating region is presented in Table 8 (mean first pass time) and Table 9 (mean total time). Within the Local Before condition, there were no significant first pass effects (all  $F$ 's  $< 1$ ). Total time measures, however, revealed a significant main effect of global context,  $F(1,47) = 9.45$ ,  $p < .01$ ,  $MSE = 125111$ ;  $F(1,47) = 13.18$ ,  $p < .001$ ,  $MSE = 97472$ . Readers spent more time in the disambiguating region when the global context was biased towards the dominant meaning of the ambiguous word. This result makes sense because the local disambiguating information was always biased towards the subordinate meaning of the ambiguous word.

Table 8. Mean first pass time (ms) on the Local Before disambiguating region

	Local Before	
	Global Subordinate	Global Dominant
Ambiguous Target	1908	1983
Control Target	1906	1950
<i>Difference scores</i>	2	33

Table 9. Mean total time (ms) on the Local Before disambiguating region

	Local Before	
	Global Subordinate	Global Dominant
Ambiguous Target	2212	2353
Control Target	2134	2231
<i>Difference scores</i>	78	122

In the Global Dominant Local Before condition, a discrepancy should be apparent upon reading the disambiguating context because a new constituent is introduced into the discourse at this point. In order to determine if the discrepancy was noticed prior to reading the target word, a go past measure was utilized (see Table 10). It is possible that the significant effect of global context in the total time measure may reflect rereading times after having gone past the disambiguating region and encountering the ambiguous target word. This was not the case. Readers spent more time in this region when the global context was biased towards the dominant interpretation of the ambiguous word.

Table 10. Mean go past time (ms) on the Local Before disambiguating region

	Local Before	
	Global Subordinate	Global Dominant
Ambiguous Target	2000	2134
Control Target	2013	2055
<i>Difference scores</i>	-13	79

An ANOVA on the go-past times for the Local Before disambiguating region (the region up to, but not including the target word) supported this finding,  $F(1,47) = 4.14$ ,  $p < .05$ ,  $MSE = 82504$ ;  $F(1,47) = 5.21$ ,  $p < .05$ ,  $MSE = 70956$ . This result indicates that the reader became aware of the context change before encountering the target word. A

second pass or rereading rate of less than 20% further reinforces the idea that the global context effects found in the total time measures did not involve going back to this region for further processing after seeing the target word. Readers spent more time in the Local Before disambiguating region when the target word was ambiguous,  $F(1,47) = 4.14$ ,  $p < .05$ ,  $MSE = 82504$ ;  $F(1,47) = 5.21$ ,  $p < .05$ ,  $MSE = 70956$ . This is entirely a result of second pass or rereading times. It is only after the reader moved on to encounter the target word that they returned to spend more time in the Local Before disambiguating region.

Time spent in the Local After disambiguating region is presented in Table 11 (mean first pass time) and Table 12 (mean total time). First pass effects revealed that readers spent more time in the Local After disambiguating region when it followed an ambiguous word than when it followed a control word,  $F(1,47) = 6.14$ ,  $p < .05$ ,  $MSE = 804608$ ;  $F(1,47) = 5.09$ ,  $p < .05$ ,  $MSE = 151210$ . Readers were also more likely to spend additional time in the disambiguating region when the global context was biased towards the dominant meaning of the ambiguous target word. This effect was significant by subjects,  $F(1,47) = 5.35$ ,  $p < .05$ ,  $MSE = 136321$ ; but only marginally significant by items,  $F(1,47) = 3.32$ ,  $p < .08$ ,  $MSE = 210697$ . The effect of ambiguity is larger for the global dominant condition. There was a two-way interaction between global context and ambiguity. This effect was only significant by subjects, not items  $F(1,47) = 5.61$ ,  $p < .05$ ,  $MSE = 105013$ ;  $F(1,47) = 1.79$ ,  $p < .2$ ,  $MSE = 194579$ . Total time effects also revealed a significant main effect of ambiguity,  $F(1,47) = 23.13$ ,  $p < .0001$ ,  $MSE = 88091$ ;  $F(1,47) = 15.44$ ,  $p < .001$ ,  $MSE = 118528$ ; readers spend more time in the Local After disambiguating region when it followed an ambiguous word than when it followed a

control word. In addition, readers were significantly more likely to spend extra time in the disambiguating region when the global context was biased towards the dominant meaning of the ambiguous word than when the global context was biased towards the subordinate meaning of the ambiguous word,  $F1(1,47) = 31.60$ ,  $p < .0001$ ,  $MSE = 68948$ ;  $F2(1,47) = 17.86$ ,  $p < .001$ ,  $MSE = 123253$ . The effect of ambiguity was larger when the global context was biased towards the dominant rather than the subordinate meaning of the ambiguous target word. A significant interaction between global context and ambiguity supported this finding,  $F1(1,47) = 8.25$ ,  $p < .01$ ,  $MSE = 60784$ ;  $F2(1,47) = 4.13$ ,  $p < .05$ ,  $MSE = 104058$ .

Table 11. Mean first pass time (ms) on the Local After disambiguating region

	Local After	
	Global Subordinate	Global Dominant
Ambiguous Target	1916	2122
Control Target	1874	1910
<i>Difference scores</i>	<i>42</i>	<i>212</i>

Table 12. Mean total time (ms) on the Local After disambiguating region

	Local After	
	Global Subordinate	Global Dominant
Ambiguous Target	2336	2645
Control Target	2236	2355
<i>Difference scores</i>	<i>100</i>	<i>290</i>

## Summary

No effect of ambiguity was found in the first pass reading times in the Local Before conditions. This finding was expected as the reader had not yet encountered the ambiguous target word. There was also no effect of global context in first pass times. The total time measures, however, indicated that there was an effect of global context and that readers noticed the change in contextual bias in the Global Dominant Local Before condition. Additional analyses using go past processing measures suggested that the reader was aware of the shift in context before encountering the target word.

Readers spent more time in the Local After condition following an ambiguous target word than its corresponding control word. In all conditions the control words were more easily integrated into the ongoing discourse representation. The greatest processing difficulty was found when the global context was biased towards the dominant meaning of the ambiguous target word. Up to this point in the paragraph, there was no indication that the dominant interpretation of the ambiguous word was incorrect. Presumably, the reader had previously incorporated the dominant meaning of the target word into the ongoing discourse bias. The Local After disambiguating information provides evidence that the readers' initial interpretation was incorrect after meaning selection and integration had occurred. As a result, a time consuming re-analysis was required once the discrepant information was encountered. This resulted in prolonged reading times in the Global Dominant Local After condition when local disambiguating information followed the ambiguous target word. The numerical difference apparent in the disambiguating region for in the Global Subordinate Local After condition was not statistically significant. Some potential interpretations of the above findings are presented in the General Discussion.



## CHAPTER 4

### DISCUSSION

The purpose of the present experiment was to examine the contributions of global and local context effects on lexical ambiguity resolution. The results of the current experiment replicate previous eye movement studies (Binder, 1999; Binder & Morris, 1995; Binder & Rayner, 1998; Duffy et al., 1988; Rayner et al., 1994; Rayner & Frazier, 1989). As in these prior experiments, gaze durations were longer on subordinately biased ambiguous words than on unambiguous control words. The longer gaze durations on the ambiguous target words are characteristic of the subordinate bias effect, and are believed to be an indication of processing difficulty due to accessing multiple meanings of the ambiguous target word. According to the subordinate bias effect, the subordinately biased contextual information increases the level of activation for the less dominant interpretation of the ambiguous target word which results in a lengthy selection and integration process (and longer reading times). The selective access model cannot account for increased processing time found on biased ambiguous words. Thus, this study provides further evidence in support of the reordered access model of lexical ambiguity resolution. The pattern of results found here again demonstrate that the order in which the meanings of an ambiguous word becomes available can be influenced by the prior sentence context.

What is important to note, however, is that the ambiguous target word was read more slowly than its corresponding control word when any portion of the preceding discourse was biased toward the subordinate meaning of the ambiguous word. That is, the subordinate bias effect emerged either when the global context or the preceding local context instantiated the subordinate meaning of the biased ambiguous word. In addition,

only when no local disambiguating information was available to assist the reader in choosing the appropriate meaning of the ambiguous target word (in the Global Subordinate Local After condition), did the global context show any influence on initial processing measures (such as lexical access).

Previous research (Binder, 1999; Binder & Rayner, 1998; Rayner et al., 1994) has indicated that initial processing of a biased ambiguous word is strongly influenced by the preceding local context. In the current study, there is again no evidence that the global context is able to influence the initial processing of a biased ambiguous target word in the presence of local contextual information. Only when no local contextual information was available prior to encountering the ambiguous target word did the global context have an immediate effect on ambiguity resolution. Presumably, this is because the reader has to rely on other sources of information to ensure coherent comprehension of the ongoing discourse when preceding local disambiguating information is not available. In the Global Subordinate Local After condition, the only available disambiguating contextual information was contained within the global context. This was the only condition in which the global context appeared to be having an impact on initial processing measures (i.e. lexical access).

When biasing local context is available prior to encountering the ambiguous target word, global context does not have any additional effect on lexical ambiguity resolution. Further support for this argument lies in the fact that the magnitude of the subordinate bias effect in the Global Subordinate Local Before condition was the same as in the other two conditions (Global Subordinate Local After and Global Dominant Local Before). The effect of having two sources of subordinately biased contextual information prior to the

ambiguous target word did not increase the magnitude of the effect of the biasing information on the ambiguous target word. This result is consistent with Rayner et al.'s (1994) second experiment who also manipulated the amount of subordinately biased contextual information available to the reader prior to encountering a biased ambiguous target word. In their experiment, Rayner et al. failed to achieve selective activation of the subordinate interpretation of the ambiguous target word even when the amount of biasing contextual information was increased.

Another indication that the global contextual information may not typically affect initial processing measures is that the inconsistency between the global and local contextual bias in the Global Dominant Local Before condition also had no effect on the magnitude of the subordinate bias effect on the target word. In fact, an analysis on second pass (or re-reading) times on the target word was the first indication that global contextual information was influencing processing of the target word (see footnote 3) as indicated by a main effect of global context that was not present in first pass reading times.

The appearance of the subordinate bias effect on the target word in the Global Dominant Local Before condition, however, indicates that subordinately biased local context was able to significantly increase the activation for the subordinate meaning of the ambiguous word in spite of the dominantly biased global context. Thus, the local context demonstrated a more immediate impact on lexical ambiguity resolution than the global dominant contextual information.

When the discourse contained no preceding subordinately biased sentential context (within either the global or local context), there was no difference in initial processing times between the ambiguous target word and the control word. This result is

unsurprising, as in that condition (Global Dominant Local After) the dominant meaning of the ambiguous word was the first meaning available upon encountering the target word. This result is consistent with all of the models of ambiguity resolution.

The three way interaction observed in the spill over effects, however, suggests that the inconsistency between the Global Dominant and the Local Before contextual information did affect post-access processing of the ambiguous target word. Presumably, the inconsistency between the global and local context delayed the reader's ability to select and integrate a particular meaning into the ongoing discourse representation (reflected in post-access processing difficulties). Increased reading times in the post-target region in the Global Dominant Local Before condition further indicate that readers had difficulty in recovering from the conflicting information.

A number of models have been proposed to account for the effect that context has on lexical access. According to discourse models (Hess et al., 1995; Sharkey & Sharkey, 1992), lexical processing is directly affected by the ongoing discourse representation, not the local context. As a result, proponents of the discourse models would predict a different pattern of results than those found in the present experiment. For example, if the global context is biased towards the dominant meaning of the ambiguous target word (and the rest of the paragraph is consistent with that interpretation), then presumably the dominant interpretation of the ambiguous word should be facilitated. According to the discourse model, the global context has an immediate impact on lexical ambiguity resolution. Thus, if the reader encountered the Global Dominant context, then the dominant interpretation should be favored by the reader regardless of whether local contextual information available immediately preceding the ambiguous target word



conflicted with the bias introduced in the global context. This would result in reading times consistent with the control word (thus no subordinate bias effect) in both the Global Dominant Local Before and the Global Dominant Local After conditions. As the reading times on the ambiguous target word were different than its corresponding control word for the Global Dominant Local Before condition, the discourse models of lexical processing were not supported.

In opposition to the discourse models of lexical processing, the evidence reported above is consistent with the hybrid models of lexical processing (Kintsch, 1988; Schwanenflugel & White, 1991; Schustack, et al., 1987) in which both global and local contexts affect word processing. An important question is the nature of the contribution of the global and local contextual information. The present experiment supports the theory that global and local contexts are both having an impact on lexical ambiguity resolution. Local context appears to be having an impact on the initial stages of word processing (e.g. lexical access). Global context also has an immediate impact on word processing, but only in the absence of preceding local contextual information. What remains unclear, however, is whether global context typically has an immediate impact on the processing of a lexically ambiguous word when local contextual information is also available. That is, there was no additional effect of global and local context. When preceding local contextual information was available to the reader it influenced initial processing of the target word and there was no apparent effect of global context. For example, when local contextual information preceded the target word, the information encountered in the global context did not appear to influence lexical access of the target



word. Presumably, the proximity of the local context allowed it to have an immediate impact on processing while the effect of the more distant global contextual information was obscured.

When no preceding local contextual information was available, global contextual information was able to influence lexical access. The immediate effect of global context on the ambiguous target word is not inconsistent with the reordered access model (Duffy et al., 1988). The reordered access model was designed to address the general effect of context on access of ambiguous words. According to the proponents of the reordered access model, meaning frequency and prior context influence the order in which meanings become available. When no immediately preceding local context was available before encountering the target word, the global context was the sole source of contextual influence. As the reordered access model does not assume that a priming mechanism is responsible for accessing a particular meaning of an ambiguous word, the distance of the global context to the ambiguous target word does not present a problem for the model.

Given that the current experiment has provided evidence which indicates that both global and local contexts affect lexical access, there are models that can account for why distant (global) information can have an immediate impact on word processing. The immediate impact of global context in the absence of preceding local disambiguating information is consistent with the predictions of the resonance model (Klin, 1995, Klin & Myers, 1993; Myers & O'Brien, 1998; Murray, Klin, & Myers, 1993). When a reader encounters information with overlapping features to elements located earlier in the text, there is no cost associated with reinstating the information. How this works is that elements stored in memory resonate when new input shares features with the information

already stored in memory. The resonance process is fast and automatic. In addition, only the relevant elements in memory resonate when their features overlap with new input. Thus, the elements in memory established by the global context are accessed directly via feature overlap when the ambiguous target word is encountered. As a result, the distance between the global context and the target word is irrelevant. When the features of an ambiguous target word overlap with elements stored in memory relating to the global context, an active, time-consuming search process is unnecessary. Instead, the information becomes available quickly due to a fast, automatic process based on argument or featural overlap.

Although the distance between the global context and the target word allowed for an immediate impact on later word processing (in the absence of any local biasing contextual information), one issue remains unclear. Previous research (Lorch, 1995; Kieras, 1978, 1980; Kintsch & van Dijk, 1978) has indicated that there may be special properties associated with the information presented as the topic of a discourse. In the present experiment, the global context was always instantiated as the topic of the paragraph. According to Lorch (1995), information presented as the topic of a text is privileged such that the topic of a paragraph is potentially a critical focus for the integration of successive information in the text. As a result, the information presented in the topic of a paragraph may be more readily available than information that is equally distant but lacking the special status of topicality. Further research is necessary to determine whether it was an aspect of these special properties (related to being the topic of the paragraph) that allowed the subordinately biased global context to have an immediate impact on word processing in later portions of the text.

In conclusion, some new evidence has been provided to help distinguish the locus of context effects on ambiguity resolution. More research is still necessary. As it stands, the hybrid models of context effects and the reordered access model seem best suited to accurately predicting the data. In the current experiment, the subordinately biased contextual information was able to increase the level of activation for the less likely interpretation of the ambiguous word, regardless of where it was located in the discourse. Both the global and the local contextual information were able to cause the subordinate bias effect on the ambiguous target word. It is important to note that the global context effects only appeared on the target word when no other more immediate source of information was available. In addition, the magnitude of the effect did not change when additional biasing information was available. The fact that global context effects were immediate (as demonstrated by the main effect for ambiguity in first fixation times), indicates that global contextual information can be reinstated quickly when no other more immediate source of information is available. There is no clear evidence, however, as to whether global and local contexts are distinct in their influence on word processing in this experiment. What can be said, however, is that distant global contextual information can become immediately available in the absence of local contextual information. The speed with which this information becomes available can be accounted for by the resonance theory as well as by the special status of discourse topicality.

## REFERENCES

- Binder, K. S. (in press). Sentential and discourse context effects on lexical ambiguity processing: an eye movement examination. Memory and Cognition.
- Binder, K. S. & Morris, R. K. (1995). Eye movements and lexical ambiguity resolution: Effects of prior encounter and discourse topic. Journal of Experimental Psychology: Learning, Memory, and Cognition, 21, 1-11.
- Binder, K. S. & Rayner, K.A. (1999). Contextual strength does not modulate the subordinate bias effect: Evidence from eye fixations and self-paced reading. Psychonomic Bulletin & Review, 5, 271-276.
- Blank, M. A. (1980). Measuring lexical access during sentence processing. Perception and Psychophysics, 28, 1-8.
- Blank, M. A., and Foss, D. J. (1978). Semantic facilitation and lexical access during sentence processing. Memory and Cognition, 6, 644-652.
- Burgess, C. & Simpson, G. B., (1988). General mechanisms in the retrieval of ambiguous word meanings. Brain and Language, 33, 86-103.
- Cole, R. A. and Jakimik, J. (1979). Understanding speech. How words are heard. In G. Underwood (Ed.), Strategies of Information Processing. New York: Academic Press.
- Conrad, C. (1974). Context effects in sentence comprehension: A study of the subjective lexicon. Memory and Cognition, 2, 130-138.
- Dopkins, S., Morris, R. K. & Rayner, K. (1992). Lexical ambiguity and eye fixations in reading: A test of competing models of lexical ambiguity resolution. Journal of Memory and Language 31, 461-477.
- Duffy, S. A., Henderson, J. M., and Morris, R. K. (1989). Semantic facilitation of lexical access during sentence processing. Journal of Experimental Psychology: Learning, Memory, and Cognition, 15, 791-801.



Duffy, S. A., Morris, R. K., & Rayner, K. (1988). Lexical ambiguity and fixation times in reading. Journal of Memory and Language, 27, 429-446.

Foss, D. J. (1982). A discourse on semantic priming. Cognitive Psychology, 14, 590-607.

Foss, D. J. and Ross, J. R. (1983). Great expectations: Context effects during sentence processing. In G. Flores D'Arcais & R. J. Jarvella (Eds.). The process of language understanding (pp. 169-191). Chichester, England: Wiley.

Francis, W., & Kucera, H. (1982). Word frequency counts of modern English. Providence RI: Brown University Press.

Glucksberg, S., Kreuz, F.J., Rho, S. H. (1986). Context can constrain lexical access: Implications for models of language comprehension. Journal of Experimental Psychology: Learning Memory and Cognition, 12, 323-335.

Hess, D. J., Foss, D. J., and Carroll, P. (1995). Effects of global and local context and lexical processing during language comprehension. Journal of Experimental Psychology: General, 124, 62-82.

Kieras, D. E. (1978). Good and bad structure in simple paragraphs: Effects on apparent theme, reading time, and recall. Journal of Verbal Learning and Verbal Behavior, 17, 13-28.

Kintsch, W. (1988). The role of knowledge in discourse comprehension: A construction-integration model. Psychological Review, 95, 163-182.

Kintsch, W., & Mross, E. F. (1985). Context effects in word recognition. Journal of Memory and Language, 24, 336-349.

Kintsch, W. & van Dijk, T.A. (1978). Toward a model of text comprehension and production. Psychological Review, 85, 363-394.

Klin, C. M. (1995). Causal inferences during reading: From immediate activation to long-term memory. Journal of Experimental Psychology: Learning, Memory, and Cognition, 21, 1483-1494.



Klin, C. M. & Myers, J. L. (1993). Reinstatement of causal information during reading. Journal of Experimental Psychology: Learning, Memory, and Cognition, 19, 554-560.

Lorch, R. F. (1995). The integration of topic information during reading. In R. F. Lorch and E. J. O'Brien (Eds.), Sources of Coherence in Reading (pp. 279-294). Hillsdale, NJ: Lawrence Erlbaum Associates.

Lucas, M. M. (1987). Frequency effects on the processing of ambiguous words in sentence contexts. Language and Speech, 30, 25-46.

Marslen-Wilson, W. D. & Welsh, A. (1978). Processing interactions and lexical access during word recognition in continuous speech. Cognitive Psychology, 10, 29-63.

Meyer, D. E. & Schvaneveldt, R. W. (1971). Facilitation in recognizing pairs of words: Evidence of a dependence between retrieval operations. Journal of Experimental Psychology, 90, 227-234.

Meyer, D. E. & Schvaneveldt, R. W. (1976). Meaning, memory structure, and mental processes. Science, 197, 27-33.

Morris, R. K. (1994). Lexical and message-level sentence context effects on fixation times in reading. Journal of Experimental Psychology: Learning, Memory, and Cognition, 20, 92-103.

Morrison, R. E. (1984). Manipulations of stimulus onset delay in reading: Evidence for parallel programming of saccades. Journal of Experimental Psychology: Human Perception and Performance, 10, 667-682.

Murray, J. D., Klin, C. M., & Myers, J. L. (1993). Forward inferences in narrative text. Journal of Memory and Language, 32, 464-473.

Myers, J. L. & O'Brien, E. J. (1998). Accessing the discourse representation during reading. Discourse Processes, 26, 131-157.

Neill, W.T. (1989). Lexical ambiguity and context An activation-suppression model. In D.S. Gorfein (Ed.), Resolving Semantic Ambiguity (pp. 63-83). New York, NY: Springer-Verlag.

Neill, W.T., Hilliard, D.V., & Cooper, E. (1988). The detection of lexical ambiguity: Evidence for context sensitive parallel access. Journal of Memory and Language, 27, 279-287.

Onifer, W. & Swinney, D. A. (1981). Accessing lexical ambiguities during sentence comprehension: Effects of frequency, meaning, and contextual bias. Memory & Cognition, 9 225-236.

O'Seaghdha, P. (1989). The dependence of lexical relatedness effects on syntactic connectedness. Journal of Experimental Psychology: Learning, Memory, and Cognition, 15, 73-87.

Paul, S.T., Kellas, G., Martin, M., & Clark, M. B. (1992). The influence of contextual features on the activation of ambiguous word meanings. Journal of Experimental Psychology: Learning Memory, and Cognition, 18, 703-717.

Rayner, K. & Duffy, S. A. (1986). Lexical complexity and fixation times in reading: Effects of word frequency, verb complexity, and lexical ambiguity. Memory & Cognition, 14, 191-201.

Rayner, K. & Frazier, L. (1989). Selection mechanisms in reading lexically ambiguous words. Journal of Experimental Psychology: Learning, Memory, and Cognition, 15, 779-790.

Rayner, K. & Pollatsek, A. (1989). The Psychology of Reading. Englewood Cliffs, N.J.: Prentice Hall.

Rayner, K. Pacht, J.M. & Duffy, S. A. (1994). Effects of prior encounter and discourse bias on the processing of lexically ambiguous words: Evidence from eye fixations. Journal of Memory and Language, 33, 527-544.

Schustack, M. W., Ehrlich, S. F., & Rayner, K. (1987). Local and global sources of contextual facilitation in reading. Journal of Memory and Language, 26, 232-252.

Schvaneveldt, R. W., Meyer, D. E., & Becker, C. A. (1976). Lexical ambiguity, semantic context and visual word recognition. Journal of Experimental Psychology: Human Perception and Performance, 2, 243-256.

Schwanenflugel, P.J. & White, C. R. (1991). The influence of paragraph information on the processing of upcoming words. Reading Research Quarterly, 26, 160-177.

Seidenberg, M. S., Tanenhaus, M. K., Leiman, J. M., & Bienkowski M. (1982). Automatic access of the meanings of ambiguous words in context: Some limitations of knowledge based processing. Cognitive Psychology, 14, 489-537.

Sereno, S. C. (1995). The resolution of lexical ambiguity: Evidence from an eye movement Paradigm. Journal of Experimental Psychology: Learning, Memory, and Cognition, 21, 582-595.

Sereno, S. C., Pacht, J. M. & Rayner, K. (1992). The effect of meaning frequency on processing lexically ambiguous words: Evidence from eye fixations. Psychological Science, 3, 296-300.

Sharkey, A. J. C., & Sharkey, N. E. (1992). Weak contextual constraints in text and word priming. Journal of Memory and Language, 31, 543-572.

Simpson, G. B. (1981). Meaning dominance and semantic context in the processing of lexical ambiguity. Journal of Verbal Learning and Verbal Behavior, 20, 120-136.

Simpson, G. B. (1984). Lexical ambiguity and its role in models of word recognition. Psychological Bulletin, 96, 316-340.

Simpson, G. B. (1994). Context and the processing of ambiguous words. In M. A. Gernsbacher (Ed.), Handbook of Psycholinguistics. San Diego: Academic Press.

Simpson, G. B. & Burgess, C. (1985). Activation and selection processes in the recognition of ambiguous words. Journal of Experimental Psychology: Human Perception and Performance, 11, 28-39.

Simpson, G. B. & Krueger, M. A. (1991). Selective access of homograph meanings in sentence context. Journal of Memory and Language, 30, 627-643.

Stanovich, K. E. & West, R. F. (1981). The effect of sentence context on ongoing word recognition: Tests of a two-process theory. Journal of Experimental Psychology: Human Perception and Performance, 7, 159-165.

Stanovich, K. E. & West, R. F. (1983). On priming by a sentence context. Journal of Experimental Psychology: General, 112, 1-36.

Swinney, D. A. (1979). Lexical access during sentence comprehension: (Re)consideration of context effects. Journal of Verbal Learning and Verbal Behavior, 18, 645-659.

Swinney, D. A. & Hakes, D. T. (1976). Effects of prior context upon lexical access during sentence comprehension. Journal of Verbal Learning and Verbal Behavior, 15, 681-689.

Swinney, D. A., Onifer, W., Prather, P., & Hirshkowitz, M. (1979). Semantic facilitation across modalities in the processing of individual words and sentences. Memory and Cognition, 7, 159-165.

Tabossi, P. (1988). Accessing lexical ambiguity in different types of sentential contexts. Journal of Memory and Language, 27, 324-340.

Tabossi, P., Colombo, L., & Job, R. (1987). Accessing lexical ambiguity: Effects of context and dominance. Psychological Research, 49, 161 - 167.

Tanenhaus, M. K., Leiman, J. M. & Seidenberg, M. S. (1979). Evidence for multiple stages in the processing of ambiguous words in syntactic contexts. Journal of Verbal Learning and Verbal Behavior, 18, 427-440.

Till, R. E., Mross, E. F., & Kintsch, W. (1988). Time course of priming for associate and inference words in a discourse context. Memory & Cognition, 16, 283-298.

Twilley, L. C., Dixon, P., Taylor, D., & Clark, (1984). University of Alberta norms of relative meaning frequency for 566 homographs. Memory & Cognition, 2, 111-126.





DATE DUE			

## UNIVERSITY LIBRARY

UNIVERSITY OF MASSACHUSETTS  
AMHERST

LD  
3234  
M268  
1999  
K155





